

# Reliability Failure induced by the Si Epitaxy Growth on PMOS High Voltage Oxide in 0.15um Embedded Flash Memory Devices

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Recently, it has been paid significant attention to develop the Flash memory devices. As the design rule is scaled down, the reliability requirement has become more challenging in the areas of endurance cycling, DHTL and high voltage GOI. This paper will be focusing specifically on an anomaly found in the Flash memory product during high voltage GOI testing.

One of the key circuitries in the Flash memory devices is the charge pump to supply enough voltage to the control gate for the programming. In general, the charge pump consists of high voltage (HV) transistors and HV capacitors. During our 0.15um Flash process qualification, it was observed that the charge to breakdown (Qbd) of PMOS high voltage oxide was degraded, although the NMOS high voltage oxide did not show any degradation.

Test showed that out of the four different gate oxides in these embedded Flash devices, Qbd degradation took place in the thickest oxide, which was the HV oxide (210A). This is of special interest as normally the thick oxide is more susceptible to the impact ionization. A further test was done, and the I-V measurement on the degraded oxide showed the oxide breakdown (Fig. 1). Failure Analysis was also performed using Transmission Electron Microscopy (TEM) to identify the breakdown mechanism. Surprisingly, it was discovered that it was Si epitaxy growth on the HV oxide which resulted in the oxide breakdown. (Fig. 2) In addition, the Co silicide, which is generally found at the top of the poly, was found to be missing. Interestingly, the location of the missing Co silicide directly corresponds to the newly discovered Si epitaxy growth.

From the experimental results, it was confirmed that the unusual Si epitaxy growth on PMOS HV oxide is attributed to the process-induced stress.

For the first time ever, the possible mechanism of stress-induced Si Epitaxy growth on HV oxide will be reported, and we will share the process solution to prevent the reliability failure on HV oxide in the charge pump of 0.15um embedded Flash devices.

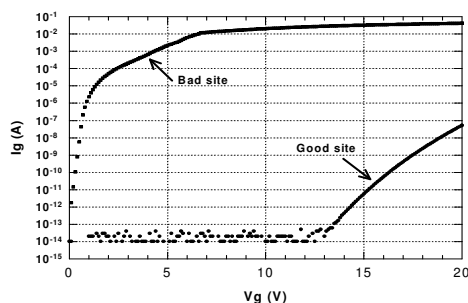


Fig. 1 Gate current vs. gate voltage at bad and good sites.

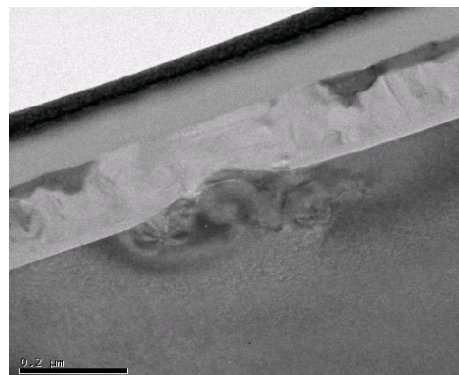


Fig. 2 Si epitaxy growth on PMOS HV oxide.